
Bibliography.

---

(19) [Country of Issue] Japan Patent Office (JP)
(12) [Official Gazette Type] Open patent official report (A)
(11) [Publication No.] JP,6-204191,A.
(43) [Date of Publication] July 22, Heisei 6 (1994).
(54) [Title of the Invention] The surface treatment method after metal plug formation.
(51) [The 5th edition of International Patent Classification]
H01L 21/302 N 9277-4M.
21/28 B 7376-4M.
21/318 C 7352-4M.
[Request for Examination] Un-asking.
[The number of claims] 7.
[Number of Pages] 7.
(21) [Filing Number] Japanese Patent Application No. 5-232409.
(22) [Filing Date] August 24, Heisei 5 (1993).
(31) [Priority Document Number] Japanese Patent Application No. 4-326129.
(32) [Priority Date] Common 4 (1992) November 10.
(33) [Country Declaring Priority] Japan (JP)
(71) [Applicant]
[Identification Number] 000002185.
[Name] Sony Corp.
[Address] 6-7-35, Kitashinagawa, Shinagawa-ku, Tokyo.
(72) [Inventor(s)]
[Name] Shinohara Keiji.
[Address] 6-7-35, Kitashinagawa, Shinagawa-ku, Tokyo Inside of Sony Corp.
(74) [Attorney]
[Patent Attorney]
[Name] Flying bridge Country rule.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

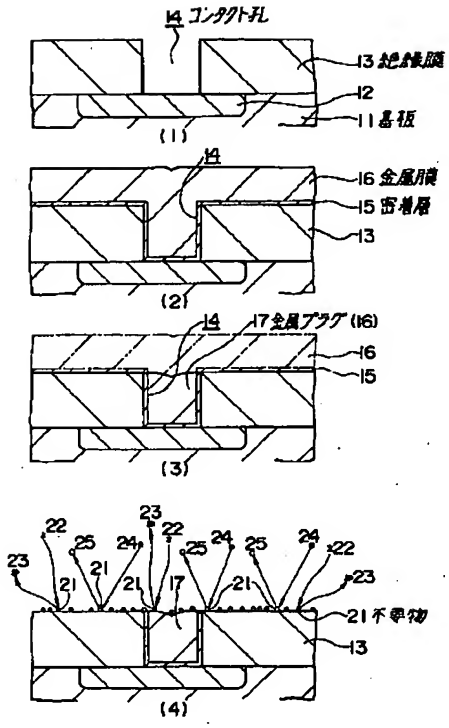
1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

Summary.

---

(57) [Abstract]
[Objects of the Invention] After this invention forms a metal plug, it is removing the factor which generates an after corrosion, and aims at improvement in the quality of wiring linked to a metal plug.
[Elements of the Invention] the contact prepared in the insulator layer 13 -- after forming the metal plug 17 in a hole 14, it is the method of removing the discard 21 adhering to each front face, by exposing to the atmosphere which plasma-ized hydrogen gas or ammonia gas, or the atmosphere which plasma-ized water as reducing gas which includes the front face of the metal plug 17, and the front face of an insulator layer 13 for a hydrogen atom Or it is the method of removing discard, by plasma-izing rare gas and carrying out sputtering of each front face. In each above-mentioned surface treatment, it is also possible to heat a substrate in 50-degree-C or more temperature of 650 degrees C or less.

[Translation done.]



第1の実施例のプラグ形成工程および表面処理の説明図

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] the contact prepared in the insulator layer on a substrate -- a hole, after forming a metal membrane inside and on the insulator layer concerned In the surface treatment method of removing the discard which left the metal membrane concerned only inside, formed the metal plug in it, and adhered to the front face of the account metal plug of back to front, and the front face of the aforementioned insulator layer carrying out etchback of the aforementioned metal membrane -- the aforementioned contact -- a hole -- The surface treatment

method after the metal plug formation characterized by carrying out by exposing the reducing gas which includes removal of the aforementioned discard for a hydrogen atom to the plasma-ized atmosphere.
[Claim 2] The surface treatment method after the metal plug formation whose reducing gas containing the aforementioned hydrogen atom is characterized by the bird clapper from hydrogen gas or ammonia gas in the surface treatment method after metal plug formation according to claim 1.
[Claim 3] the contact prepared in the insulator layer on a substrate -- a hole, after forming a metal membrane inside and on the insulator layer concerned In the surface treatment method of removing the discard which left the metal membrane concerned only inside, formed the metal plug in it, and adhered to the front face of the account metal plug of back to front, and the front face of the aforementioned insulator layer carrying out etchback of the aforementioned metal membrane -- the aforementioned contact -- a hole -- The surface treatment method after the metal plug formation characterized by performing removal of the aforementioned discard by exposing water to the plasma-ized atmosphere.
[Claim 4] the contact prepared in the insulator layer on a substrate -- a hole, after forming a metal membrane inside and on the insulator layer concerned In the surface treatment method of removing the discard which left the metal membrane concerned only inside, formed the metal plug in it, and adhered to the front face of the account metal plug of back to front, and the front face of the aforementioned insulator layer carrying out etchback of the aforementioned metal membrane -- the aforementioned contact -- a hole -- The surface treatment method after the metal plug formation characterized by performing removal of the aforementioned discard by plasma-izing rare gas and carrying out sputtering.
[Claim 5] In the surface treatment method after a claim 1, a claim 2, and metal plug formation according to claim 3 or 4 After performing surface treatment by the aforementioned surface treatment method, the surface treatment method concerned is the different surface treatment method. The surface treatment method of exposing the reducing gas containing a hydrogen atom to the plasma-ized atmosphere, The surface treatment method of exposing the reducing gas which consists of hydrogen gas or ammonia gas to the plasma-ized atmosphere, The surface treatment method after the metal plug formation characterized by performing surface treatment by at least one surface treatment method in the surface treatment method of exposing water to the plasma-ized atmosphere, and the surface treatment method which plasma-izes rare gas and carries out sputtering.
[Claim 6] The surface treatment method after the metal plug formation characterized by setting to the surface treatment method after a claim 1, a claim 2, a claim 3, and metal plug formation according to claim 4 or 5, and heating the aforementioned substrate at the time of the aforementioned surface treatment in 50-degree-C or more temperature of 650 degrees C or less.
[Claim 7] It is the surface treatment method after the metal plug formation characterized by the bird clapper from that in which the aforementioned metal membrane contains a tungsten, molybdenum, plastic CHINIUMU, copper, a

silicide compound, or aluminum in the surface treatment method after a claim 1, a claim 2, a claim 3, a claim 4, and metal plug formation according to claim 5 or 6.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the surface treatment method after metal plug formation especially about the method applied to the manufacture method of a semiconductor device.
[0002]
[Description of the Prior Art] detailed-izing of the design rule of a semiconductor device -- following -- contact -- the path of a hole is also becoming small However, most thickness of the layer insulation film for securing isolation voltage has not changed. consequently, contact -- the aspect ratio of a hole is large for this reason -- the case where wiring is formed only by the aluminum film -- contact -- since the covering nature of the aluminum film in the level difference section of a hole is not good -- contact -- defective continuity is produced with a hole and the reliability of a semiconductor device is reduced
[0003] moreover -- as the another wiring formation method -- contact -- the reduction reaction of the 6 tungsten fluoride (WF6) after forming a hole -- using -- contact -- the so-called selection tungsten-CVD (chemical vapor growth) method which forms a tungsten (W) film only in the interior of a hole is proposed this method -- all contacts -- the contact from which it is difficult with which to carry out the selective growth of the tungsten to a hole completely, and the depth differs -- it has the theoretic technical problem that a hole cannot be embedded simultaneously
[0004] The so-called blanket tungsten-CVD is proposed as a method of solving the above-mentioned technical problem. this method -- contact -- after forming a hole -- contact -- the interior of a hole -- contact -- a tungsten film is formed also on the insulator layer in which the hole was formed an after that tungsten film -- etchback -- carrying out -- contact -- it leaves a tungsten film only to the interior of a hole the contact from which film formation can be easily performed and the depth moreover differs by this method rather than the selection tungsten-CVD

which gave [above-mentioned] explanation -- it becomes possible to embed a hole simultaneously

[0005] after forming the nitriding titanium oxide (TiON) layer for raising adhesion with the silicon-oxide (SiO2) film which is an insulator layer in the above-mentioned blanket tungsten-CVD -- contact -- a hole -- it is possible to embed inside by the tungsten film In this case, since a nitriding titanium oxide layer's functioning as a barrier layer and the melting point of a tungsten are 3380 degrees C and the invasion of the tungsten to the inside of a silicon substrate is suppressed, for example even if it forms membranes at an elevated temperature comparatively, a good electrical property is acquired.

[0006] next, blanket tungsten-CVD and etchback technology -- contact -- drawing 5 explains how to form a tungsten plug in the interior of a hole

[0007] As shown in (1) of drawing 5 , the diffusion layer 42 is formed in the upper layer of a silicon substrate 41. Moreover, the layer insulation film 43 which consists of a silicon oxide (SiO2) is formed by the upper surface of the above-mentioned silicon substrate 41. a phot first usual lithography technology and first usual etching -- the above-mentioned layer insulation film 43 on the above-mentioned diffusion layer 42 -- contact -- a hole 44 is formed

[0008] subsequently, it is shown in (2) of drawing 5 -- as -- for example, a reactant spatter -- contact -- the film 45 which carried out the laminating of (Titanium Ti) film 45a and the nitriding titanium oxide (TiON) 45b to the wall of a hole 44 and the front face of the layer insulation film 43 one by one is formed In addition, it is also possible to use a titanium-nitride (TiN) film etc. instead of a nitriding titanium oxide film. Then, the tungsten film 46 is deposited on the front face of the film 45 which carried out the laminating of titanium film 45a and the nitriding titanium oxide 45b one by one, for example using a cold-wall type CVD system.

[0009] As shown in (3) of drawing 5 after that, as gas containing a fluorine, by etching using the etching gas which consists of a sulfur hexafluoride (SF6), etchback of the above-mentioned tungsten film 46 is carried out, and the portion shown according to the two-dot chain line of drawing is removed. and contact -- the tungsten plug 47 which consists of a tungsten film 46 is formed in the interior of a hole 44 Moreover, what is necessary is just to perform etchback to a sulfur hexafluoride as gas containing chlorine instead of the etching gas which consists of the above-mentioned sulfur hexafluoride using the etching gas which added chlorine (Cl2), in carrying out etchback also of the film 45 which carried out the laminating of titanium film 45a on the layer insulation film 43, and the nitriding titanium oxide 45b one by one and removing it at the time of the above-mentioned etchback.

[0010] In order to form a metal wiring layer furthermore, as shown in drawing 6 , the titanium (Ti) film 48 and the nitriding titanium oxide (TiON) film 49 are formed on the tungsten plug 47 and the layer insulation film 43. Furthermore, the aluminum-silicon (aluminum-Si) film 50 is formed.

[0011]

[Problem(s) to be Solved by the Invention] However, by the method of forming the above-mentioned tungsten plug, discard, such as a resultant generated at the

time of the fluorine (F) used by etchback on the tungsten film which performed etchback, and the layer insulation film, chlorine (Cl), or etchback, adheres. After discard had adhered, when a metal wiring layer which gave [above-mentioned] explanation is formed, discard will be incorporated between a tungsten plug and a titanium film. For this reason, after processing an aluminum-Si film, the corrosion of the aluminum called after corrosion occurs under the influence of the chlorine which remains as discard.

[0012] moreover -- the case where a tungsten film is formed by blanket tungsten-CVD -- a tungsten film -- contact -- since it is formed from a base [of a hole], and side-attachment-wall side -- contact -- the portion which the tungsten film grew and contacted becomes the tungsten film concerned in the interior of a hole with a joint Since membranes are not formed in the state dense enough, this joint is brittle. For this reason, at the time of etchback, the etch rate of this joint becomes early, and although it is small at a joint, a slit-like crevice is formed. Moreover, when the level difference is formed in the layer insulation film, over etching is usually performed so that the etching remainder in the level difference section may not be produced. At this time, a joint **********s and the portion becomes a concave impression.

[0013] Where slit-like a crevice and a concave impression are produced as mentioned above, when wet etching for removing discard is performed, the water used for slit-like a crevice and a concave impression at the time of washing after an etching reagent or etching invades and remains. When an aluminum film is formed in this state, the remaining etching reagent, aluminum, or remaining water and remaining aluminum react, and an aluminum film is corroded. Consequently, the reliability of wiring falls and the quality of a semiconductor device falls off.

[0014] the wiring which connects this invention to a metal plug -- reliability -- it aims at offering the surface treatment method after the metal plug formation for forming highly

[0015]

[Means for Solving the Problem] this invention is the surface treatment method after the metal plug formation made in order to attain the above-mentioned purpose. namely, the contact prepared in the insulator layer on a substrate -- a hole -- carrying out etchback of the metal membrane, after forming a metal membrane inside and on an insulator layer -- contact -- a hole -- it is the method of removing by exposing the reducing gas which contains a hydrogen atom for the discard which left the metal membrane only inside, formed the metal plug in it, and adhered to the front face of a metal plug, and the front face of an insulator layer after that to the plasma-ized atmosphere For example, hydrogen gas or ammonia gas is used for reducing gas.

[0016] Or it is also possible to remove the discard concerned by exposing discard to the atmosphere which plasma-ized water. Or it is also possible to remove discard, when rare gas is plasma-ized and carries out sputtering.

[0017] moreover, after performing surface treatment by the above-mentioned surface treatment method, as the different surface treatment method from the surface treatment method The surface treatment method of exposing the reducing gas containing a hydrogen atom to the plasma-ized atmosphere, The

surface treatment method of exposing the reducing gas which consists of hydrogen gas or ammonia gas to the plasma-ized atmosphere, Surface treatment is performed by at least one surface treatment method in the surface treatment method of exposing water to the plasma-ized atmosphere, and the surface treatment method which plasma-izes rare gas and carries out sputtering.
[0018] It is desirable to heat a substrate in 50-degree-C or more temperature of 650 degrees C or less at the time of the above-mentioned surface treatment. A metal membrane can still also be formed including a tungsten, molybdenum, plastic CHINIUMU, copper, a silicide compound, or aluminum.
[0019]
[Function] By the above-mentioned surface treatment method, the discard concerned is removed by exposing the discard adhering to the front face of a metal plug, and the front face of an insulator layer to the atmosphere which plasma-ized the reducing gas containing a hydrogen atom. Therefore, since it was lost that an etching reagent, water, etc. remain into the portion of the joint of a metal membrane, when the aluminum system metal membrane used for wiring is formed, the aluminum system metal membrane is not corroded.
[0020] Moreover, by having used hydrogen gas or ammonia gas for the above-mentioned etching gas, a halogen atom or molecules, such as a fluorine, become a hydrogenation halogen with high vapor pressure among discard. For this reason, it becomes easy to secede from a hydrogenation halogen from the front face of a metal plug, or the front face of an insulator layer. The same operation as the above is obtained also by exposing discard to the atmosphere which furthermore plasma-ized the above-mentioned water.
[0021] Furthermore, by exposing discard to the atmosphere which plasma-ized rare gas, the spatter of the front face of a metal plug or the front face of an insulator layer is carried out. For this reason, discard is removed by spatter operation. Under the present circumstances, since the chemical action in a metal plug front face is not produced, the joint portion of a metal plug does not **********.
[0022] After performing one of surface treatment among the above-mentioned surface treatment, discard is removed with the first surface treatment by performing surface treatment by one method in the different surface treatment method from the surface treatment concerned, without **********ing the joint portion of a metal plug, and the discard produced at the time of the first surface treatment is removed, without **********ing the joint portion of a metal plug with the next surface treatment.
[0023] A resultant, a halogen atom, or a molecule generated by plasma etching becomes easy to break away from the front face of a metal plug, or the front face of an insulator layer by setting to the surface treatment method after the above-mentioned metal plug formation, and heating the substrate at the time of plasma etching in 50-degree-C or more temperature of 650 degrees C or less.
[0024] Moreover, even if it forms the above-mentioned metal membrane including a tungsten, molybdenum, plastic CHINIUMU, copper, a silicide compound, or aluminum, the same operation is obtained with above-mentioned having given explanation.
[0025]

[Example] Explanatory drawing of the plug formation process of drawing 1 and surface treatment explains the 1st example of this invention.
[0026] the diffusion layer 12 top prepared in the upper layer of a substrate 11 by a phot usual lithography technology and usual etching as shown in (1) of drawing 1 -- and the insulator layer 13 currently formed on the substrate 11 -- contact -- a hole 14 is formed
[0027] subsequently, it is shown in (2) of drawing 1 -- as -- for example, a reactant spatter -- contact -- the adhesion layer 15 is formed in the wall of a hole 14, and the front face of an insulator layer 13 This adhesion layer 15 is formed by the nitriding titanium oxide (TiON) film which is the material of for example, a titanium (Ti) system. then, for example, blanket tungsten-CVD -- the above-mentioned contact -- a hole -- it changes into the state of embedding the 14 interior, and a metal membrane 16 is formed in the upper surface of the above-mentioned adhesion layer 15 This metal membrane 16 consists for example, of a tungsten film. In the above-mentioned blanket tungsten-CVD, the pressure of 400 degrees C and reaction atmosphere is set as 867Pa for reaction temperature (substrate temperature), for example using the reactant gas mixed at a rate of 6 tungsten 19 fluoride (WF6) to hydrogen 1.
[0028] Then, as shown in (3) of drawing 1 , the metal membrane 16 concerned on the above-mentioned insulator layer 13 is removed by carrying out etchback of the portion shown according to the two-dot chain line of the above-mentioned metal membrane 16. and contact -- the metal plug 17 which consists of the metal membrane 16 concerned is formed in the interior of a hole 14 In the above-mentioned etchback, the sulfur hexafluoride (SF6) and flow rate of 50sccm(s) use [a flow rate] mixed gas with the chlorine (Cl2) of 10sccm(s) for etching gas, for example, and 1.3Pa and microwave power are set as 1kW, and they set RF bias as 10W for the pressure of etching atmosphere. In the above-mentioned etchback, etchback also of the adhesion layer 15 (portion shown with a dashed line) on an insulator layer 13 is carried out, and it is removed.
[0029] If the above-mentioned etchback is performed, as shown in (4) of drawing 1 , the discard 21 which consists of resultants, such as etching type-of-gas or tungsten chloride, titanium, etc. fluoride, will adhere to the front face of the above-mentioned metal plug 17, or the front face of the above-mentioned insulator layer 13. [, such as a fluorine and chlorine,]
[0030] Then, surface treatment for removing the above-mentioned discard 21 is performed. The argon which contains 4% of hydrogen which set the flow rate as 100sccm(s) in surface treatment, for example is used for a discharge gas, and the pressure of electric discharge atmosphere is set as 1.3Pa, and it discharges by setting microwave power as 1kW and setting RF bias as 5W.
[0031] By electric discharge, a discharge gas decomposes and the hydrogen radical 22 is generated. This hydrogen radical 22, and the fluorine of the discard 21 and chlorine react, and vapor pressure generates gas 23, such as high hydrogen fluoride and a hydrogen chloride. Thus, the fluorine and chlorine adhering to the front face of the metal plug 17 or the front face of an insulator layer 13 are removed. Moreover, a sputtering operation of the argon ion 24 removes the resultants 25, such as tungsten chloride [of the discard 21],

titanium, etc. fluoride, from the front face of the metal plug 17, or the front face of an insulator layer 13.
[0032] Although the argon gas which mixed hydrogen was used for the above-mentioned discharge gas, it is also possible to use the reducing gas which can also use ammonia (NH3), for example, and contains hydrogen atoms, such as hydrocarbon gas, such as methane (CH4).
[0033] Moreover, a removal reaction will be promoted if a substrate 11 is heated at 50 degrees C or more 650 degrees C or less at the time of the above-mentioned surface treatment. In addition, when the temperature of a substrate 11 is lower than 50 degrees C, a removal reaction is suppressed, and when the temperature of a substrate 11 is higher than 650 degrees C, the function as a barrier metal of the adhesion layer 15 is lost.
[0034] Next, drawing 2 explains the 2nd example.
[0035] the contact prepared in the insulator layer 13 by performing the process explained by (1) - (3) of drawing 1 of the 1st example of the above as shown in drawing -- the metal plug 17 is formed in the interior of a hole 14 Then, the argon gas (it acts as carrier gas) and the flow rate of 100sccm(s) use for a discharge gas that with which the flow rate mixed H2 O of 30sccm(s), for example, and set the pressure of electric discharge atmosphere as 1.3Pa, and discharge by setting microwave power as 1kW and setting the temperature of 5W and a substrate 11 as 250 degrees C for RF bias.
[0036] By electric discharge, H2 O decomposes and the hydrogen radical 22 is generated. This hydrogen radical 22, and the fluorine and chlorine of discard 21 react, and vapor pressure generates gas 23, such as high hydrogen fluoride and a hydrogen chloride. Thus, the fluorine and chlorine adhering to the front face of the metal plug 17 or the front face of an insulator layer 13 are removed. Moreover, a sputtering operation of the argon ion 24 removes the resultants 25, such as tungsten chloride [of the discard 21], titanium, etc. fluoride, from the front face of the metal plug 17, or the front face of an insulator layer 13.
[0037] Moreover, although the temperature of a substrate 11 was heated at 250 degrees C at the time of the above-mentioned surface treatment, when a substrate 11 is heated at 50 degrees C or more 650 degrees C or less, for example, the removal reaction of discard 21 is promoted similarly. In addition, when the temperature of a substrate 11 is lower than 50 degrees C, a removal reaction is suppressed, and when the temperature of a substrate 11 is higher than 650 degrees C, the function as a barrier metal of the adhesion layer 15 is lost.
[0038] Next, drawing 3 explains the 3rd example of the surface treatment method.
[0039] the contact prepared in the insulator layer 13 by performing the process explained by (1) - (3) of drawing 1 of the 1st example of the above as shown in drawing -- the metal plug 17 is formed in the interior of a hole 14 Then, for example, a flow rate uses the argon gas of 100sccm(s) for a discharge gas, the pressure of electric discharge atmosphere is set as 1.3Pa, and it discharges by setting microwave power as 1kW and setting the temperature of 10W and a substrate 11 as 250 degrees C for RF bias.
[0040] The argon ion 24 occurs by electric discharge. RF bias accelerates in the

substrate 11 direction, and incidence of this argon ion 24 is carried out to the front face of the metal plug 17, or the front face of an insulator layer 13. And a sputtering operation removes the discard 21 which consists of resultants, such as halogen atom and tungstens fluoride, such as a fluorine and chlorine, and tungsten chloride, from the front face of the metal plug 17, or the front face of an insulator layer 13.

[0041] Moreover, although the temperature of a substrate 11 was heated at 250 degrees C at the time of the above-mentioned surface treatment, when a substrate 11 is heated at 50 degrees C or more 650 degrees C or less, for example, the removal reaction of discard 21 is promoted similarly. In addition, when the temperature of a substrate 11 is lower than 50 degrees C, a removal reaction is suppressed, and when the temperature of a substrate 11 is higher than 650 degrees C, the function as a barrier metal of the adhesion layer 15 is lost.

[0042] Next, drawing 4 explains the 4th example of the surface treatment method.

[0043] the contact prepared in the insulator layer 13 by performing the process explained by (1) - (3) of drawing 1 of the 1st example of the above as shown in (1) of drawing 4 -- the metal plug 17 is formed in the interior of a hole 14 Then, the argon gas (it acts as carrier gas) and the flow rate of 100sccm(s) use for a discharge gas that with which the flow rate mixed H2 O of 30sccm(s), for example, and set the pressure of electric discharge atmosphere as 1.3Pa, and discharge by setting microwave power as 1kW and setting the temperature of 5W and a substrate 11 as 250 degrees C for RF bias.

[0044] By electric discharge, H2 O decomposes and the hydrogen radical 22 is generated. This hydrogen radical 22, and the fluorine and chlorine of discard 21 react, and vapor pressure generates gas 23, such as high hydrogen fluoride and a hydrogen chloride. Thus, the fluorine and chlorine adhering to the front face of the metal plug 17 or the front face of an insulator layer 13 are removed.

[0045] At this time, titanium oxide (TiO2) or a tungstic oxide (WO2) is generated by a reaction with unreacted H2 O, or the reaction with the oxygen radical which carried out electric discharge decomposition with the metal plug 17 at the metal plug 17 and electric discharge, and it may become discard 26 and may remain.

[0046] For this reason, as shown in (2) of drawing 4 , when discard 26 remains, it will be necessary to remove the discard 26. A sputtering operation of the argon ion 24 performs removal of the above-mentioned discard 26. As the processing condition, a flow rate uses the argon gas of 100sccm(s) for a discharge gas, for example, the pressure of electric discharge atmosphere is set as 1.3Pa, and it discharges by setting microwave power as 1kW and setting the temperature of 10W and a substrate 11 as 250 degrees C for RF bias.

[0047] The argon ion 24 occurs by electric discharge. RF bias accelerates in the substrate 11 direction, and incidence of this argon ion 24 is carried out to the front face of the metal plug 17, or the front face of an insulator layer 13. And a sputtering operation removes the above-mentioned discard 26 from the front face of the metal plug 17, or the front face of an insulator layer 13.

[0048] Moreover, although the temperature of a substrate 11 was heated at 250 degrees C at the time of the above-mentioned surface treatment, when a

substrate 11 is heated at 50 degrees C or more 650 degrees C or less, for example, the removal reaction of discard 21 and 26 is promoted similarly. In addition, when the temperature of a substrate 11 is lower than 50 degrees C, a removal reaction is suppressed, and when the temperature of a substrate 11 is higher than 650 degrees C, the function as a barrier metal of the adhesion layer 15 is lost.

[0049] Although the sputtering operation of argon ion removed discard 26 in the 4th example which gave [above-mentioned] explanation after the hydrogen radical 22 which decomposed and obtained H2 O first as an example removed discard 21, it is also possible to carry out combining one of the two or more surface treatment methods explained in the examples 1, 2, and 3 according to the kind of adhering discard. And it is suitably determined by the kind of discard to which the way of combining has adhered.

[0050] Although the explanation in each above-mentioned example explained the case where a tungsten (W) film was used for a metal membrane 16, as well as the above when it forms for example, by the metal membrane containing molybdenum, plastic CHINIUMU, copper, a silicide compound, or aluminum, it is possible to remove discard 21 and 26.

[0051] Moreover, it is not limited to a microwave plasma etching system, for example, the equipment which can perform the above-mentioned surface treatment can use various etching systems, such as an parallel monotonous type etching system, a magnetron reactive ion etching system, or a downflow type processor.

[0052]

[Effect of the Invention] As mentioned above, since the discard generated by the front face of a metal plug and the front face of an insulator layer is exposed to the atmosphere which plasma-ized hydrogen gas or ammonia gas as reducing gas containing a hydrogen atom according to this invention as explained, discard is removable. Moreover, since this processing is dry processing, into the portion of the joint formed in a metal plug, the component which corrodes the aluminum film which is wiring does not remain. Therefore, reliable wiring formation is attained and improvement in the quality of a semiconductor device can be aimed at.

[0053] Moreover, when rare gas is plasma-ized when exposing and removing discard in the atmosphere which plasma-ized water, and a spatter operation removes discard, the same effect as the above is acquired.

[0054] Since surface treatment is performed by one method in the different surface treatment method from the surface treatment method concerned after performing surface treatment by one of the surface treatment methods among the above-mentioned surface treatment methods, discard can be first removed with the first surface treatment, without **********ing the joint portion of a metal plug. And with the next surface treatment, the discard produced at the time of the first surface treatment can be removed, without **********ing the joint portion of a metal plug.

[0055] When heating a substrate in 50-degree-C or more temperature of 650 degrees C or less at the time of surface treatment, the removal reaction of discard can be promoted. Moreover, even if it forms a metal membrane including

a tungsten, molybdenum, plastic CHINIUMU, copper, a silicide compound, or aluminum, the same effect as the above can be acquired.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is explanatory drawing of the plug formation process of the 1st example, and surface treatment.
[Drawing 2] It is explanatory drawing of the surface treatment in the 2nd example.
[Drawing 3] It is explanatory drawing of the surface treatment in the 3rd example.
[Drawing 4] It is explanatory drawing of the surface treatment in the 4th example.
[Drawing 5] It is formation process drawing of the tungsten plug of the conventional example.
[Drawing 6] It is explanatory drawing of the metal wiring layer of the conventional example.
[Description of Notations]
11 Substrate 13 Insulator Layer
14 Contact -- Hole 16 Metal Membrane
17 Metal Plug 21 Discard
26 Discard

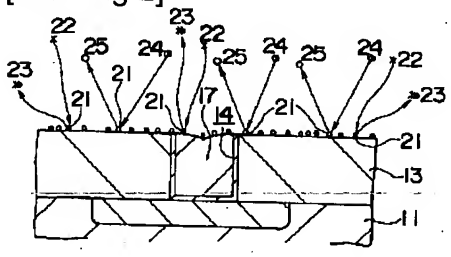
[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

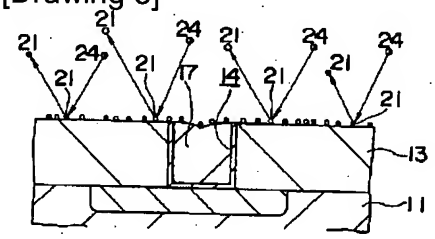
DRAWINGS

[Drawing 2]



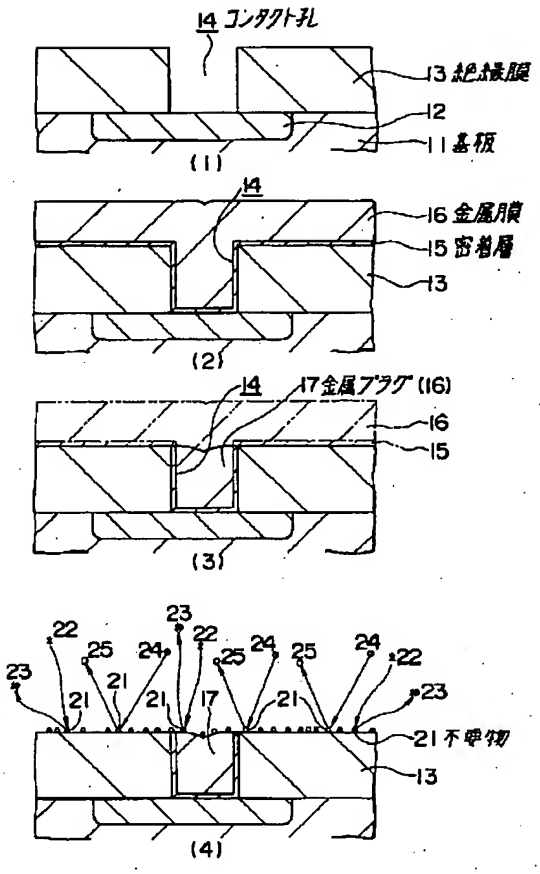
第2の実施例における表面処理の説明図

[Drawing 3]



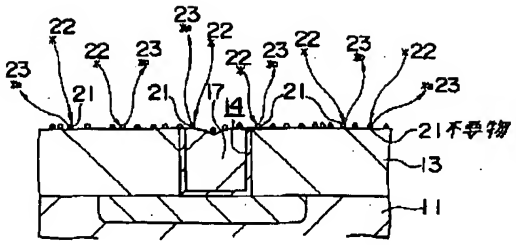
第3の実施例における表面処理の説明図

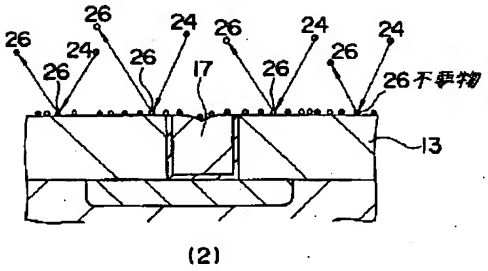
[Drawing 1]



第1の実施例のプラグ形成工程および表面処理の説明図

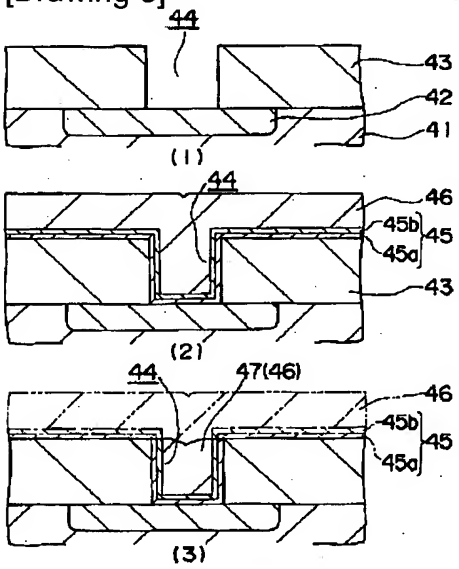
[Drawing 4]





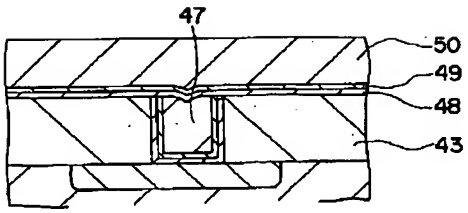
第4の実施例における表面処理の説明図

[Drawing 5]



従来例のタングステンプラグの形成工程図

[Drawing 6]



従来例の金属配線層の説明図

[Translation done.]